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flower inflorescences. This peculiar type of pistillate inflorescence seems definitely confined to the class of plants combining the tunicate and ramosa characters.

The cauliflower character, which in itself would seem more nearly related to ramosa than to tunicate, is somewhat more definitely associated with the ramosa than with the tunicate character of the tassels.

There were 22 plants with pure cauliflower ears. Twenty of these had tassels in which both tunicate and ramosa characters were obvious. The other two were classed as having ramosa tassels. Of the 13 plants with partial cauliflower ears 11 had ramosa tassels in which no tunicate characters were observed, and two showed evidence of both tunicate and ramosa in their tassels.

If the second-generation plants are examined for each of the parental types separately, there is seen to have been a simple 1 to 3 segregation in both instances. One-fourth of the total number of plants are ramosa and three-fourths non-ramosa (observed 79 to 247, expected 81.5 to 244.5). One-fourth are non-tunicate and three-fourths tunicate (observed 80 to 246, expected 81.5 to 244.5). The distinction between half- and full-tunicate could not be made when these characters were combined with the ramosa character. The various combinations of parental characters, occurring as they do in the normal di-hybrid ratios, show that the tunicate and ramosa characters are not genetically correlated.

The extended publication will appear in the *Journal of Agricultural Research*.

¹ Gernert, W. B., A new subspecies of *zea mays* L., *Amer. Nat.*, Lancaster, Pa., 1912, 46 (616-622).

² Blaringhem, Louis, *Mutation et traumatismes*, Paris, 1907, (121-122).

DISTRIBUTION OF GALL MIDGES

By E. P. Felt

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The intimate relation existing between many species of these tiny, fragile flies and their food plants and the relatively limited migratory ability of either adults (owing to their weak powers of flight), or the larvae (due to their apodous or nearly apodous condition), led to a study of the distribution of these highly variable forms. The immensity of the complex may be appreciated by remembering that approximately three hundred genera and probably nearly three thousand species are known—the largest about 6 mm. in length and the smallest less than 0.5 mm. long. Some live in decaying or dead organic matter, others

prey upon mites and certain insects, while a very large majority produce characteristic galls upon the different parts of a great variety of plants. Not a few are inhabitants of blossom buds, with a very limited period for feeding and growth and an extended estivation or hibernation, while many others pursue these vital activities through most of the growing season. Summarizing, we may state that great structural variations and equally marked physiological and ecological adaptations are accompanied by a puny organization and a world-wide distribution. What are the most important factors which have brought this about?

It is impossible, owing to the limited knowledge of this group from important faunal regions, to present a complete story. Fortunately there are a number of genera with sufficiently well marked characters as to render their identification reasonably certain, and for a number of these there are records from such widely separated localities as to justify the characterization of their distribution as world-wide. The presumption is against their occurring in all faunal regions, though they probably exist in most places where climate and flora combine to make this possible. There are in addition to the above, a number of genera which have been recorded from such distant countries as to justify the suspicion that they likewise may have a world-wide or nearly world-wide distribution. A tabulation of these genera is given below.

ITONID GENERA OF PRESUMABLY WORLD-WIDE DISTRIBUTION

TRIBE AND GENUS	NORTH AMERICA	SOUTH AMERICA	EUROPE	ASIA	AFRICA	AUSTRA- LIA	NEW ZEALAND
Lestremiinae							
Catocha Hald.....	+		+				
*Lestremia Macq.....	+	+	+	+		+	+
Campylomyzariae							
*Campylomyza Meign....	+		+			+	+
*Joannisia Kieff.....	+		+		+†		
Heteropezinae							
Oligarces Mein.....	+		+				
*Miastor Mein.....	+		+			+	+
Leptosyna Kieff.....	+		+				
Brachyneura Rond.....	+		+				
Spaniocera Winn.....			+			+	
Porricondyliariae							
Didactylomyia Felt.....	+			+			
Holoneurus Kieff.....	+		+				
*Colpodia Winn.....	+		+	+		+	
Dirhiza H. Lw.....	+		+				
Porricondyla Rond.....	+		+		+	+	+
Camptomysia Kieff.....	+		+				
Rubsaaemia Kieff.....	+	+	+				
*Asynapta H. Lw.....	+		+	+		+	
Winnertzia Rond.....	+		+			+	

ITONID GENERA OF PRESUMABLY WORLD-WIDE DISTRIBUTION—*Continued*

TRIBE AND GENUS	NORTH AMERICA	SOUTH AMERICA	EUROPE	ASIA	AFRICA	AUSTRA- LIA	NEW ZEALAND
<i>Dasyneuriariae</i>							
<i>Cystiphora</i> Kieff.	+		+				
<i>Rhabdophaga</i> Westw.	+		+				
<i>Dasyneura</i> Rond.	+	+	+	+	+	+	
<i>Diarthronomyia</i> Felt.	+		+				
<i>Lasiopteryx</i> Westw.	+		+				
<i>Oligotrophiariae</i>							
<i>Rhopalomyia</i> Rubs.	+	+	+	+	+		
<i>Oligotrophus</i> Latr.	+	+	+	+	+	+	
<i>Janetiella</i> Kieff.	+	+	+				
<i>Phytophaga</i> Rond.	+		+			+	
<i>Asphondyliariae</i>							
<i>Schizomyia</i> Kieff.	+		+	+	+		
§ <i>Cincticornia</i> Felt.	+		+			+	
<i>Asphondylia</i> H. Lw.	+	+	+	+	+	+	
<i>Lasiopteriae</i>							
<i>Trotteria</i> Kieff.	+		+				
* <i>Lasioptera</i> Meign.	+	+	+	+	+	+	
<i>Aplonyx</i> De Stef.	+		+				
<i>Clinorhyncha</i> H. Lw.	+		+				
<i>Itonididinae</i>							
<i>Contarinia</i> Rond.	+		+			+	
<i>Thecodiplosis</i> Kieff.	+		+				
<i>Dentifibula</i> Felt.	+			+			
<i>Dicrodiplosis</i> Kieff.	+		+				
<i>Bremia</i> Rond.	+		+				
<i>Aphidoletes</i> Kieff.	+		+			+	
<i>Karschomyia</i> Felt.	+	+					
<i>Mycodiplosis</i> Rubs.	+	†‡	+	+			
<i>Clinodiplosis</i> Kieff.	+	+	+	+			
<i>Diadiplosis</i> Felt.		+		+			
<i>Arthrocnodax</i> Rubs.	+	+	+	+			
<i>Hormomyia</i> H. Lw.	+		+				
<i>Pseudhormomyia</i> Kieff.	+		+	+			
<i>Monarthropalpus</i> Lab.	+		+				
<i>Hyperdiplosis</i> Felt.	+	†‡					
<i>Lestodiplosis</i> Kieff.	+	+	+	+	+	+	
<i>Itonida</i> Meign.	+	+	+	+		+	+
<i>Parallelodiplosis</i> Rubs.	+		+				
<i>Cystodiplosis</i> Kieff. and Jorg.	+	+					

* Recorded from the Baltic amber of the upper Eocene.

† Seychelles.

‡ St. Vincent.

§ *Polystepha* Kieff. and *Eocincticornia* Felt are included because of obvious affinities.

An examination of the above tabulation shows that representatives of all the tribes are known from most of the continental areas and probably occur on all, since allowance should be made for our scanty

knowledge of the fauna in the more remote regions. Furthermore, the more primitive genera, such as *Lestremia*, *Campylomyza*, *Porricondyla*, *Dasyneura*, *Oligotrophus*, *Asphondylia*, *Lasioptera*, *Contarinia* and *Lestodiplosis*, to take representatives from the various tribes, are found on most of the continental areas. They are represented among living forms by numerous species, many of them capable of subsisting under comparatively simple conditions and therefore not easily exterminated or isolated by adverse climatic changes.

It is noteworthy that of the seven genera known from the Baltic Amber, six are recorded also from Australia, three from New Zealand and two from Africa, and in all probability more of these genera occur in the land areas of the Southern Hemisphere. The African, Australian, New Zealand and South American faunae appear to contain a considerable number of ancient, highly specialized offshoots from the somewhat primitive world-wide genera (likewise represented) mentioned above and their occurrence suggests a zoological isolation where only the more vigorous or adaptable would establish themselves and where the natural tendency to variation would consequently be less subject to interference on the part of closely related strains or species in the process of formation.

One of the striking peculiarities in distribution is the occurrence of the genus *Aplonyx* in the Northern Hemisphere, where it is known only from the Mediterranean region and the vicinity of Salt Lake, Utah—localities favored by both host plants and insects. Species of *Didactylomyia*, a very peculiar form, occur in both North America and India, while the closely related *Erosomyia* and *Indodiplosis* are occidental and oriental, respectively.

The above and other data which need not be discussed in detail here, suggest no connection between food habits and a general distribution, since there does not appear to be a better representation of midges, such as *Lestremia* and *Porricondyla* breeding in decaying vegetable or woody tissues, materials which might easily drift to distant shores, than there is of bud or leaf-inhabiting forms which find only temporary shelter in plants and transform in the soil, such as species of *Dasyneura* and *Contarinia*. The same is true of species passing most of their existence within plant tissues, such as *Lasioptera* and *Rhabdophaga*, forms most likely to be carried great distances with the host plant. An equally wide distribution is true of predaceous midges with only a secondary relation to plants, such as *Aphidoletes*, *Myco-diplosis* and *Arthrocnodax*.

It is possible that some species may be widely disseminated through

the agency of birds, since we have records of birds feeding upon the galls of *Cincticornia* and there would appear to be no reason why those produced by the genus *Caryomyia* might not be equally acceptable. The same would be true to a certain extent of galls inhabited by *Asteromyia* and some species of *Oligotrophus*. It would be possible for midge larvae in firm, moderately thick-walled galls, to pass through the digestive tract of the bird without material injury, but this would be true of relatively few and owing to obvious limitations we can hardly consider this method of dissemination as one of great importance so far as the group as a whole is concerned.

The flight of gall midges, especially such a one as *Miastor*, is so feeble as to render it improbable that the wings of themselves are important in distributing the species over extended areas, and yet these midges are surprisingly prevalent where breeding conditions are favorable. The adults issue in swarms from decaying logs and apparently drift with the wind. The probability of this method of spread being an important one is supported by the recent investigations of McCulloch,¹ which show that Hessian flies may drift at least 2 miles with the wind. It is probable that this method of dissemination is very effective in the case of a number of gall midges.

Extended drifting, some possibly may prefer the word flight, with the wind, is not impossible when we recall that the migratory locust, *Schistocerca peregrina* has been found five hundred miles east of South America and is credited with probably having crossed from South America to Africa. Such extended flights are rendered more likely by the record of *Sphinx convolvulus* being found 420 miles from land, while other moths and longicorn beetles have been reported out at sea at a distance of 230 miles. The extensive northern flight of the cotton moth is another case of the same kind. Recent investigations by Collins² have shown that young gipsy moth caterpillars may be carried 20 to 25 miles by the wind—a distance which presumably could be greatly increased without endangering larval existence.

With the above data in mind it seems probable that the carriage of gall midges by floating vegetation and drifting islands, or by the activities of birds, has occurred to only a very limited extent and can not begin to explain the general distribution of these fragile forms. Winds undoubtedly carry these insects for short distances and might even, under exceptional conditions, transport them over seas, though this latter is by no means established and the present known distribution appears to be most easily explained by migrations (probably drifting with the wind in this group) over land areas about the same way as other mem-

bers of the fauna and the flora. There has been very probably a distribution from the north and there may have been an antarctic center of dispersion, though there appears to be no evidence within the group itself which would justify a definite opinion as to this.

¹ McCulloch, *Econ. Ent. J.*, 10, 1917, (162-168).

² *Ibid.*, 10, 1917, (170-176).

FERTILITY AND AGE IN THE DOMESTIC FOWL

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It has been shown by Marshall,¹ Pearl,² and King,³ that in a variety of different mammals fertility changes with the age of the animal in a definite way. The nature of this change is that, starting at a low point at the beginning of the sexual life, the rate of fertility rises with advancing age to a maximum, and then declines with further increase in age, until total sterility is reached. Marshall inclined to the view, on the basis of statistics which I have elsewhere⁴ shown to be wholly inadequate, that the domestic fowl exhibited the same sort of change in fertility with age. There has been no thorough or careful investigation of this matter in the fowl, based on adequate statistical material.

The writer has lately studied⁵ the change in fertility with age in poultry, on the basis of 1114 matings of Barred Plymouth Rock fowls, covering in point of time a period of nine years. For the purposes of this investigation, and generally, the writer has defined *fertility* as the total net reproductive capacity of pairs of organisms, male and female, as indicated by their ability to produce *viable* individual offspring. As a working measure of fertility may be taken a reproductive or fertility index which expresses the percentage which the number of viable offspring actually produced from a particular mating or pair of parents is of the maximum number which would be physiologically possible within the time limits during which the mating endures. This states, in most general terms, the form of index developed for the special case of poultry breeding in the present investigation. The same idea can be adapted to the measurement and biometrical study of fertility in other sorts of animals, and probably in plants as well.

Specifically, the reproductive, or fertility index used in the work for poultry has the following form:

$$RI = 100C/E_m$$